Report KSC-TR-88-001

TECHNICAL PROGRESS REPORT NUMBER 1

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Progress Report for First Month
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This project on subpixel target detection relates to research in the optimization of three-dimensional computing structures for use in target detection and to research in the reduction of an optimum computing to an efficiently-designed silicon chip. Work reported here concentrated on studies on optimizing the design of a two-dimensional cellular automaton. Our conclusion was that, for typical subpixel target detection tasks where values of the number of processing cycles is small, there is an optimum size for the triply redundant memories when values of the data window being processed are significantly smaller than the data field. This is an unexpected result and will have significant impact on further design studies.

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TECHNICAL PROGRESS REPORT

NUMBER 1

Topic Number: SDIO 88-10

Title: Three Dimensional Cellular Automata for Subpixel Target Detection

Contract Number: N00014-88-C-0717

From: Kensal Consulting, Tucson, Arizona (Code: N00014)

To: Dr. Keith Bromley, NOSC, San Diego (Code: 0D9C9)

Project Description:

This project on subpixel target detection relates to research in the optimization of three-dimensional computing structures for use in target detection and to research in the reduction of an optimum computing structure to an efficiently-designed silicon chip.

Technical Progress:

Work commenced during October and concentrated on studies on optimizing the design of cellular automata for subpixel target detection. Before approaching the more complex three-dimensional automaton, the two-dimensional automaton for subpixel target detection was studied. Assuming the Logical Transform Image Processor structure patented by Preston (US patent 4,641,351, 3 February 1987) in a two-dimensional format using a square processing window with 32 processing elements, the following equation can be written:

$$\text{TIME/WINDOW} = (W^2/32)tc$$

where WxW is the size of the data window being processed, t is the clock cycle time, and c is the number of processing cycles required.

The number of windows to be processed are given by:

$$WINDOW = S^2/(W-b)^2$$

where SxS is the size of the total data window and b is the border overlap region. (Normally b = c.)

Thus the processing rate in terms of the total task per unit time is simply

$$RATE = (W-2b)^2/S^2(W^2/32)tc$$

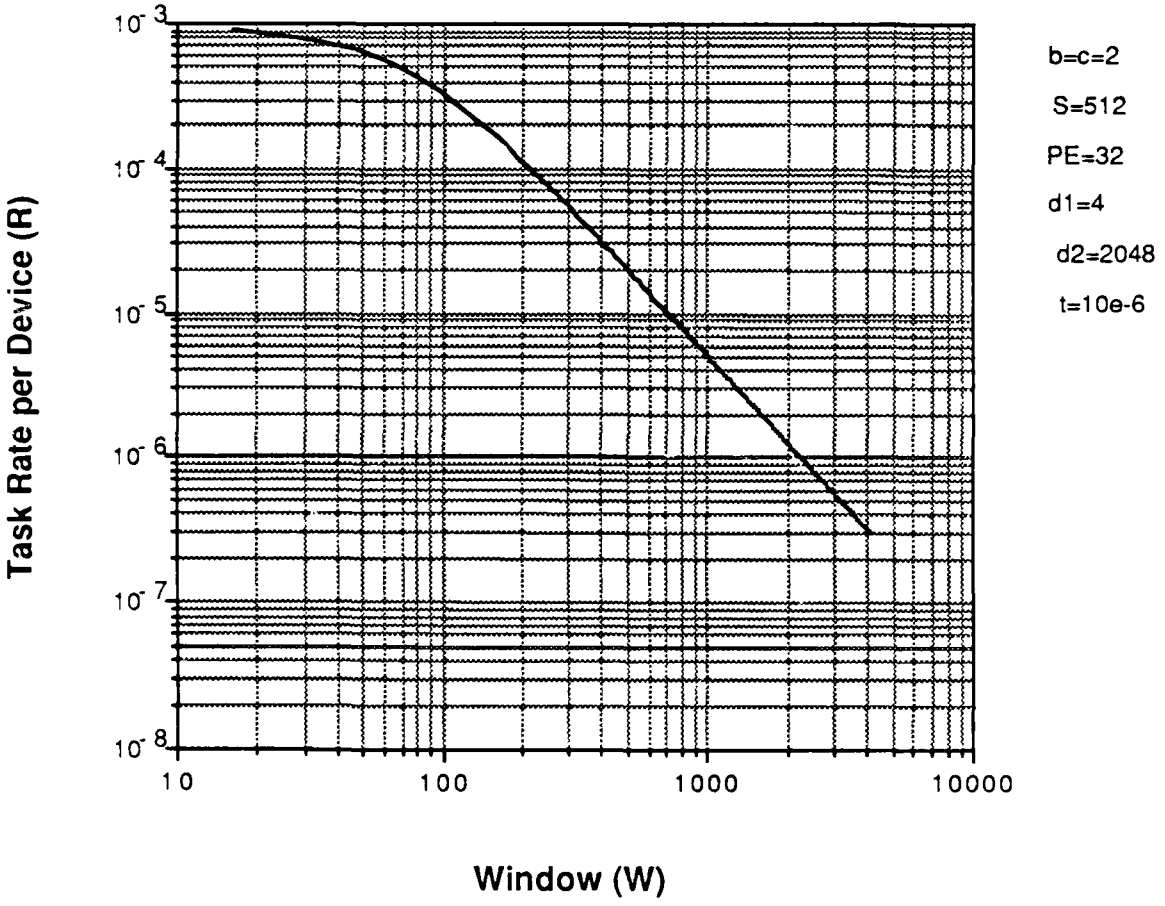
In reducing such a system to silicon we are interested in the task rate per device. There are two major consumers of devices, namely, the multiply redundant window memories and the lookup tables. For a planar processor with 32 processing elements, the number of devices in the lookup tables is simply $32d_2$ where d_2 is the number of devices in the 32 lookup tables. Assuming 4 gates per cell, d_2 is equal to 2048. Let d_1 be the number of gates per cell in the triply redundant window memories and set it equal to 4. Under these assumptions we have plotted the task rate per device under three conditions, namely, b=c=2, b=c=4, and b=c=8. These graphs are attached, based on the further assumption that t=one microsecond and the value for S is 512. It is clear from the attached graphs that for b=c=4 and b=c=8, there is an optimum value of W which is significantly smaller than S. This maximum value increases as the value of b and c increases while other parameters are held constant. Furthermore, as expected, the task rate at optimum W decreases (due to the increasing value of b and c).

Our conclusion is that, for typical subpixel target detection tasks where values of b and c are small, there is an optimum size for the triply redundant memories in a two-dimension automaton for values of W significantly smaller that S. This is an unexpected result and will have significant impact on further design studies.

Plans for November 1988:

Based on the above discoveries, and still based on two-dimensional cellular automata computing structures, we will investigate design optimization for non-rectangular windows. We will also normalize task rate by introducing the new independent variable given by pixel rate.

PHP CELLULAR WINDOW PROCESSOR



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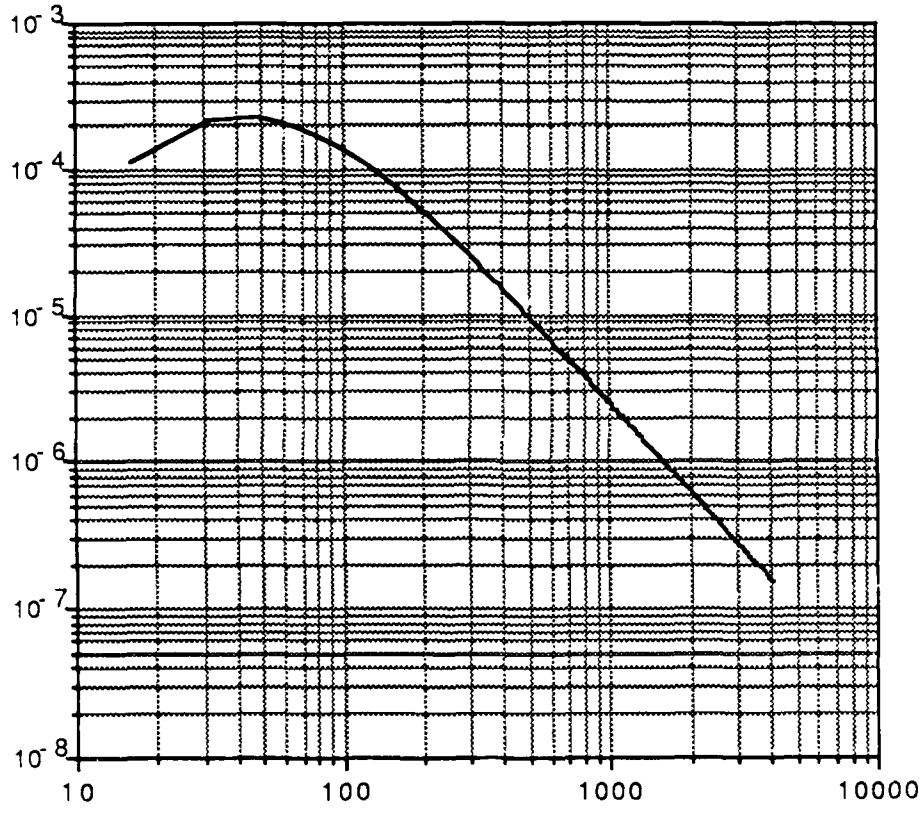

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